Toll Switchboard No. 3

By J. DAVIDSON

IN the early days of telephony the toll signaling apparatus consisted of a magnetic drop in the line and a drop or ringer in the cord. With the advent of common battery signaling in the local plant, relays and lamps replaced the old type drops and the subscriber was given means for calling the toll operator on a toll connection by operating the switchhook instead of ringing. Up to this time the toll operators were located at the local switchboard and had direct access to the subscriber's line, but with the growth of toll and local traffic, it was no longer economical to place the toll operators at the local board. This led to the development of a separate toll switchboard called the No. 1 board, which had access to the subscriber's line over switching trunks between the toll and local boards. For many years the No. 1 switchboard filled the needs of the time but with the expansion of the toll service and the growth of machine switching local service, it became evident that new arrangements were desirable. The No. 3 toll switchboard was developed to meet the new requirements and it has the following advantages as new installations are required.

(*a*) Reduction in apparatus, resulting in equipment economies.
(*b*) Improved maintenance arrangements.
(*c*) More readily adapted to modifications required by new operating methods.

In discussing the features of the No. 3 board, frequent comparisons will be made with the No. 1 switchboard to set forth the changes which have been made in the design of the new circuits.

Main Features

Cord Simplified by Locating Supervisory Relays in Line and Trunk Circuits

The cord circuit of the No. 1 switchboard is equipped with two supervisory relays. One of these relays responds to 20-cycle current and gives the toll operator a ringing signal, indicating that the distant operator is calling. The second relay responds to direct current received from the switching trunk and gives the operator switchhook supervision of the subscriber. Associated with these two relays are other relays which prevent false signals, and permit the operator to

make a busy test or use the cord for a terminating or a through connection. This cord is shown in Fig. 1.

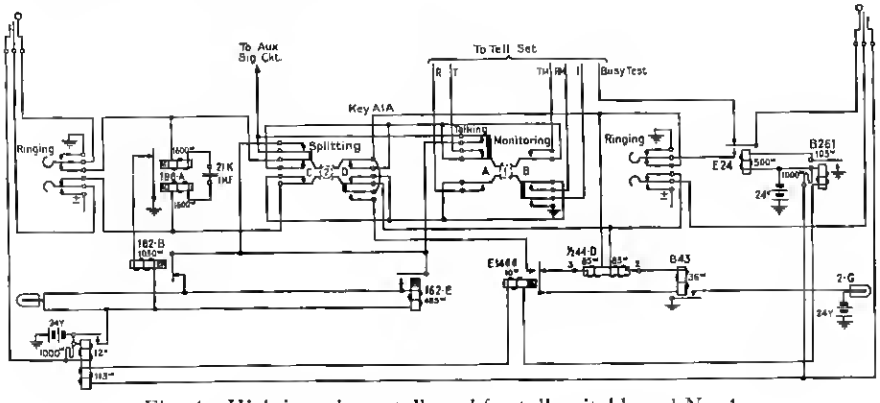

Fig. 1—High impedance toll cord for toll switchboard No. 1

In the No. 3 switchboard the ringing relay and the direct-current supervisory relay, which were formerly connected across the tip and ring conductors of the cord circuit, have been moved from the cord to the line and switching trunk, respectively, and the cord circuit has been simplified as is illustrated in Fig. 2. In this board the line and trunk

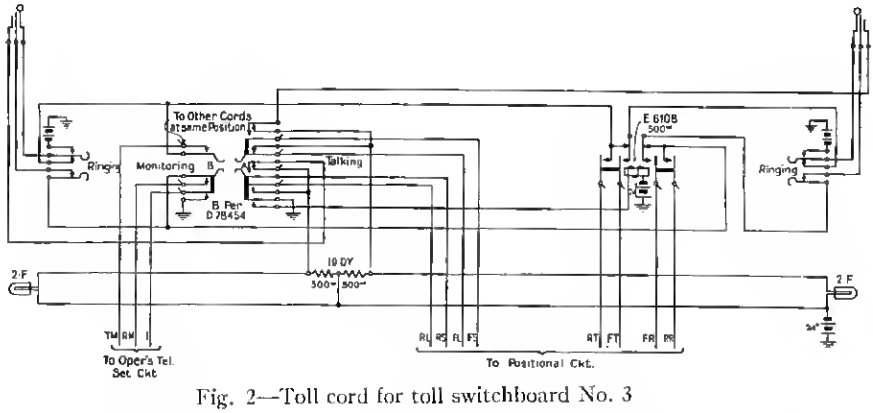

Fig. 2—Toll cord for toll switchboard No. 3

signals are transferred to the cord over the sleeve circuits. This is accomplished by using a nominal sleeve resistance of 1,800 ohms for the line and trunk circuits and connecting the lamps in the sleeves of the cord. Under these conditions there is not sufficient current flowing in the sleeve to light the lamp, but when a ringing signal is received over a line and a cord is associated with that line or when a receiver-on-the-

hook signal is received over a switching trunk, the sleeve resistance of the line or trunk is changed from 1,800 ohms to 80 ohms, which increases the current in the sleeve of the cord sufficiently to light the lamp.

Line Relay Functions in Twofold Capacity

The majority of toll lines in the plant today are of the ringdown type and the operator at one end calls the operator at the distant end by ringing over the line. To receive this ringing signal in the No. 1 board, the lines are equipped with relays which respond to the ringing current received from the distant end of the line and give a line signal. After the operator answers this signal by connecting a cord to the line, the line relay is disconnected and replaced by the ringing relay in the cord which responds to further rering signals over the line. This arrangement of the line and cord, as well as the switching trunk for the No. 1 board, is shown schematically in Fig. 3.

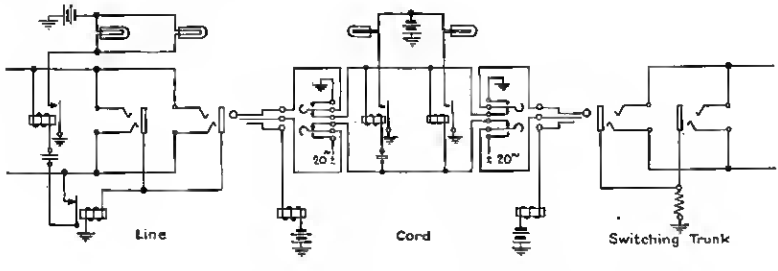

Fig. 3—Schematic: Toll switchboard No. 1 circuits

By transferring the ringing relay from the cord to the line in the No. 3 toll board, this relay is made to function in a twofold capacity, that is, to give the line signal as well as the cord rering signal. When a call is received from a distant point, the apparatus in the line functions to light the line signal and this remains lighted until a toll cord is inserted in the line jack. Further signals over the line cause the apparatus in the line to light the lamp in the cord. This is obtained by changing the sleeve resistance of the line from 1,800 ohms to 80 ohms and is illustrated in schematic form in Fig. 4. As in the past, the line signal is multipled before several operators and appears as a steady illuminated lamp which is extinguished by an operator answering the call. The cord signal appears before one operator and has been changed from a steady lamp signal to a flashing signal for the purpose of obtaining prompt attention on the part of the operator. The cord signal is extinguished when the operator connects to the circuit by the

operation of the talking key. This connects an additional 600 ohms in the sleeve circuit, which releases relays which are held operated in the line circuit and control the lamp.

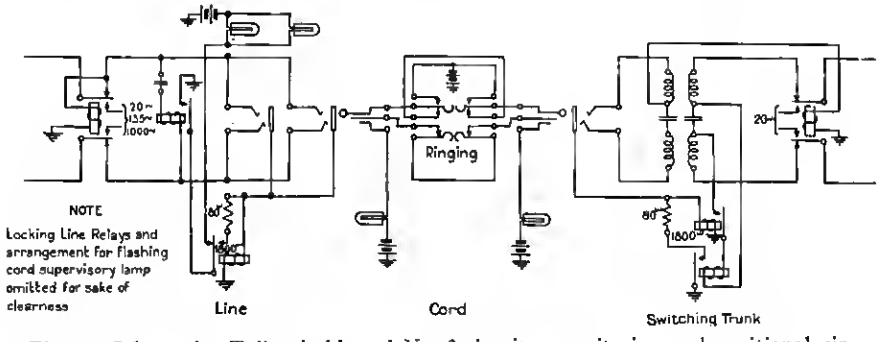

Fig. 4—Schematic: Toll switchboard No. 3 circuits; monitoring and positional circuit keys are not shown

Composite Ringer Simplified

In order that the toll lines may be used for telegraph as well as telephone service, composite sets are often connected into the line circuit at each end. These composite sets are electrical filters which separate the telephone and telegraph currents and direct the telephone currents to the switchboard and the telegraph currents to the telegraph equipment.

When composite sets are connected in the lines terminating in a No. 1 switchboard, it is also necessary to connect a composite ringer in the circuit between the composite set and the switchboard. This is necessary because the 20-cycle current, which is used as ringing current from the switchboard, is in the telegraph range of frequencies and consequently will not pass through the telephone branch of the composite set. The composite ringer substitutes for the 20-cycle outward ringing current received from the switchboard, a higher frequency current which will pass through the telephone path of the composite set. Likewise on incoming ringing signals, the ringer substitutes for the higher frequency current which comes over the line and through the telephone path of the composite set, a 20-cycle current which will operate the ringing relays of the line or cord circuits. A schematic of the composite set and composite ringer, as used with the No. 1 board, is shown in Fig. 5.

In general, the composite ringer for the No. 3 switchboard has been greatly simplified and made a part of the terminating line equipment. This has been accomplished, as illustrated schematically in Fig. 4, by arranging the line circuit so that a relay may be cross-connected in the

line to receive the 20-cycle, or the higher frequency ringing current, and arranging this relay so that it gives the line signal or the cord supervisory signal direct without going through the step of changing ringing frequencies.

Furthermore, the practice of using 20-cycle current in the cord circuit for ringing has been discontinued and ringing is effected in the No. 3 switchboard by connecting 24-volt direct current through the

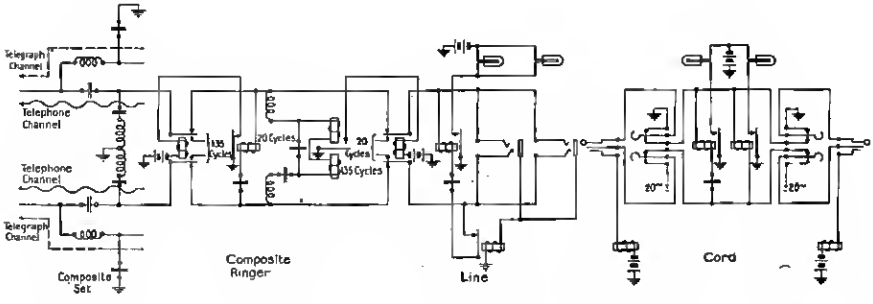

Fig. 5—Schematic: Composite ringer and composited toll line for toll switchboard No. 1

ringing key to the tip conductor of the cord. This current operates a relay of the line or trunk circuit which applies the proper frequency of ringing current to the line or trunk circuit. By this arrangement one relay in the line circuit accomplishes the same result as was accomplished by several relays in the composite ringer. As the ringing current leads to the relay in the line are brought through terminals on the frames, the line can be readily changed for any desired frequency of ringing current.

Elimination of Transfer Key from Face of Inward Switchboard

In the past the practice has been to provide one or two transfer keys per line for each multiple appearance of the line lamp at the inward toll switchboard. The function of these keys is to transfer the inward call from the inward switchboard to the outward delayed positions or to the through positions. With the No. 3 toll switchboard, the use of these transfer keys individual to the line and appearing in the face of each section of the inward switchboard has been discontinued and the transfer is effected by a transfer key in the positional circuit which may be used to transfer a call on any line. This key applies 24-volt battery either directly or through a resistance to the ring conductor of the line and operates the proper transfer relay in the toll line and causes lamps individual to that line to light at the out-

ward, or through positions. This feature not only effects a saving in equipment but saves the space in the face of the switchboard which was formerly occupied by the transfer keys.

Use of Positional Circuit

Another circuit feature of the No. 3 switchboard which marks an improvement over switchboard No. 1 is the use of a so-called positional circuit in which is located much equipment such as splitting keys, dialing keys, etc., which heretofore were individual to each cord. Under normal conditions the tip and ring conductors of the front cord are connected to the tip and ring conductors of the corresponding back cord with no shunts across the circuit. This is illustrated in Fig. 6. By the operation of the talking key associated with each cord

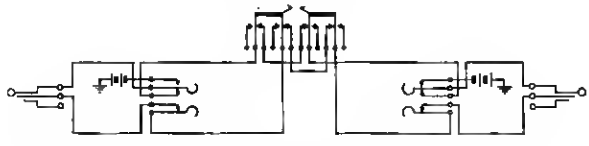

Fig. 6—Schematic: Toll cord talking circuit; talking key normal for toll switchboard No. 3

circuit, the positional circuit is connected between the front and back cords and the operator's telephone set is connected across the circuit as illustrated in Fig. 7. With the talking key of any cord operated, the operator may

(*a*) Dial on either the front or the back cord.
(*b*) Split the talking circuit between the front and the back cords.
(*c*) Transfer an inward call from the inward to the outward or the through positions.

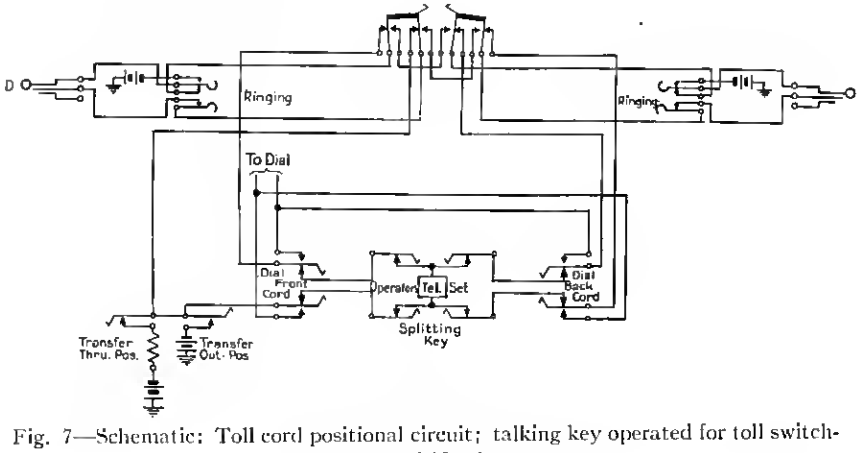

Fig. 7—Schematic: Toll cord positional circuit; talking key operated for toll switchboard No. 3

This circuit arrangement not only effects substantial economies but it is much more flexible and will lend itself to new developments without requiring changes in the cord circuit.

Monitoring and Ringing Keys Individual to Cords

The monitoring and ringing keys are, as in the past, individual to each cord.

Switching Trunk Features

In the No. 3 toll switchboard a repeating coil which has a high impedance to 20-cycle ringing current is used in the outgoing end of the switching trunk. This arrangement has equipment and signaling advantages. Also where loaded toll switching trunks are involved, the use of a repeating coil of the type referred to, but having the proper transmission characteristics, has the advantage of reducing reflection losses by providing for a uniform terminal impedance of the switching trunks.

Principal Advantages

Equipment Economies

As has been pointed out, the expansion in toll business, together with recent developments in the telephone art, have been such that with the circuit arrangements used in the past there has been a growing necessity to add equipment to the cord circuit with the result that the positions are becoming congested with apparatus. With the circuit arrangements outlined for the No. 3 toll switchboard, however, the transfer of the signaling apparatus from the cord to the line and switching trunk makes a marked simplification in the cord and incidentally reduces the congestion in the section. Also it should effect a substantial economy in equipment because of the fact that we are approaching a situation where there are approximately 60 per cent. more cords than lines and 25 per cent. more cords than switching trunks.

The use of the positional circuit and the elimination of the individual splitting key from the toll cord has simplified the switchboard keyshelf. This simplification together with the equipment savings effected by the simplification of composite ringers and the transfer of the supervisory relay equipment from the toll cord to the toll line and switching trunk circuits has effected substantial economies.

Maintenance

In addition to the saving in first cost of equipment the No. 3 switchboard facilitates maintenance. The ordinary toll cords in an office

must be suitable to work with any toll line terminating at the switchboard and consequently with the circuit arrangement used in toll switchboard No. 1, the ringing relay in all the toll cord circuits must be maintained to operate in connection with the longest as well as the shortest line circuit. In the case of the No. 3 toll switchboard, however, the ringing relay is individual to the line and consequently may be adjusted to meet the operating conditions of that line. Long lines with severe ringing conditions require the relay to have a sensitive adjustment while short lines with easy ringing conditions permit a less sensitive relay adjustment to be used which is more easily maintained.

Easily Adaptable to Machine Switching Methods

The introduction of machine switching requires provision for dialing on the trunks and may in the future require the same feature for dialing over toll lines. Such provision in the boards previously employed requires the addition of the necessary keys and relays on a "per cord" basis, whereas with the No. 3 board the equipment can be placed in the positional circuit, without any change in the cord circuit. This results in a great economy in apparatus and makes a change to a dialing basis rather simple.

SUMMARY

It is interesting to note in conclusion that heretofore an increase in cord circuit apparatus has necessarily followed the development of new and improved switchboard systems and the extension of the area of long distance communication. For example, the magneto cord with a single drop bridged across the circuit sufficed in the early days of small magneto boards. The advent of the common battery multiple switchboard brought the necessity for extending switchhook supervision to the toll operator, and resulted in the condenser-type cord consisting of 5 relays, now largely abandoned because of the relatively large transmission loss introduced by it. The high-efficiency cord consisting of 8 relays resulted from the demand for a cord having a minimum transmission loss, and additional complications have resulted in the requirement for dialing in machine switching areas, each improvement, of course, increasing the number of relays in the cord circuit. The No. 3 system, on the other hand, makes possible by the transfer of apparatus to the line and switching trunk and by the use of common positional equipment the relatively simple toll cord shown in Fig. 2 in which the individual apparatus is limited to two keys and one

relay per cord. This provides in many cases a toll cord suitable for either inward, outward or through operation, reduces the apparatus congestion in the section and results in decreased maintenance, while being easily adapted to the future trend in toll development.